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XXX. *Remarks on the very different Accounts that have been given of the Fecundity of Fishes, with fresh Observations on that Subject: By Mr. Thomas Harmer; communicated by Samuel Clark, Esq; F. R. S.*

Read May 28, 1767. **T**HE ascertaining the fecundity of the several species of fish, as far at least as we are able to do it, is one point necessary to the making our natural histories perfect; and at the same time opens a view wonderfully affecting to the imagination.

The carp, in which Petit is said to have found 342,144 eggs; and the cod, in one of which of middling size Lewenhoeck, it seems, affirmed there were 9,384,000, have been mentioned as very surprising instances of this fecundity; and by their being selected by writers, who appear to have been well versed in this part of learning, they should seem to be the most memorable we have of this kind.

The accounts, however, that have been given of the fruitfulness of these two species of fish differ from each other very considerably. For Bradley, the Botanic Professor at Cambridge some years ago, tells us in his philosophical account of the works of nature, a book professedly written on a very celebrated, though unexecuted plan,

plan \*, that the increase in some fish is surprizing, and to those that are not used to disquisitions of this kind must appear incredible ; he however sinks the number of eggs in these two species extremely, when he tells us the roe of a cod-fish must contain about a million of eggs, and that a carp does not spawn less than 20,000, to which he adds, and perhaps a tench half as many. This is making the cod almost ten times less prolific than the other account, and the carp above seventeen times less. Some other writers, who appear also to have been desirous to impress the mind with the wonders of natural history, have made their estimate still lower. One of them, I remember in particular, in one of our monthly publications, from whence numbers must take their ideas, who have no opportunity of reading more authentic accounts elsewhere, tells us, that carp and perch have nine or ten thousand eggs, and that cod-fish, and herring, are not less prolific ; and this he calls wonderful. The increase of cod-fish is indeed, even according to this, very great, but almost a thousand times less than Lewenhoeek is said to have found it.

Their accounts being so very different, I thought I should not improperly employ some leisure hours, if I inquired into this matter afresh, and saw what the fecundity of these species of fish really was, as well as of such other sorts as might fall in my way ; and especially as I had found that a small pickerel, whose spawn I had taken a pretty exact account of, from mere curiosity, some time before, contained no fewer than 25,800 eggs : a fish which

\* Proposed by Mr. Addison in one of the Spectators.

none of these authors had mentioned, and of which notwithstanding a small one had produced a larger number of eggs than Bradley himself had assigned to the carp, which has been always looked upon as remarkable for its prolific quality, not to mention the unknown writer, who makes its fecundity much less.

The make of my eyes, which are much less proper for distinguishing objects at a distance, than the seeing small things that are near; and my living in a maritime country, and though not near the sea, yet in a situation which I thought very proper for the procuring such fish as I wanted, were additional motives to the search: though as to the last particular, I have since found myself greatly disappointed.

It will not be imagined, that, in order to ascertain the real number of eggs in each fish which I examined, I told them all over one by one; this would have been, if not absolutely impracticable, at least inconsistent with other engagements, and much more fatiguing than was necessary. My way was to weigh the whole spawn very exactly; then to take a piece weighing twenty, thirty, or forty, or more grains, as was most convenient, and after weighing that parcel with care, and giving the turn of the scales to the weights, not to the eggs, to tell them over very carefully; and then by dividing the number of eggs by the grains, to find how many eggs there were in each grain, or nearly so. I say nearly, for there must, according to this method, have been rather more; but I chose to estimate them after this manner, that there might be no danger of representing the fecundity of these animals greater than the truth

truth. I frequently boiled the portions of spawn that I told, and after macerating them some hours in water, gently pressed them with a penknife, whose point I afterwards made use of to number them distinctly, by separating them from each other to greater distances, after they were rendered by that gentle squeezing fitter for telling over.

In several fish I found their eggs of very different sizes. In such cases my rule was, to tell all I could distinguish by my naked eye, and those only; though I have often found, by the help of an eye-glass, that, by thus limiting myself, I passed over great multitudes of eggs that might justly have been counted\*. I generally told them on a fine earthen

\* For, though they were very different in size, they were all, I presume, to be deposited in the proper places for hatching that season, though it may be not on the same day, since after fish are shotten, as it is called, we find no eggs at all in them. I think I do not by any means take upon me to affirm, that all fish deposit their eggs after this manner, *i. e.* by degrees, and at times a little distant from each other; but some species of them, I should think it is plain, do. This is the case of stickleback in particular, in which, when they have been extremely distended with spawn, I have found several eggs very large, but several hundreds very small, and many of them too small to be counted distinctly by an unassisted eye, which smaller ones could never, I apprehend, grow to the size the larger ones had grown to before the larger ones were excluded. I have seen some of these eggs so large, that 24 or 25 would weigh a grain; about which size, I believe, they are excluded, since some of that bulk came away from one of those creatures after it was taken out of the water, and were found in the paper in which it was wrapped up: but generally upon opening these fish they are not quite so large, though very large in comparison of many of the rest. I told in one of these smallest of fishes, which weighed very little more than 14 gr. spawn and all, about 936 eggs, some of which almost eluded my eye, besides

vessel, which was extremely black, by which means I could much better discern them, than I otherwise should have been able to do. The weights I have reckoned by are Avoirdupois weights; but there being no weights of that sort small enough to answer all purposes, I was obliged to make use of grains along with them, of which I reckon  $437\frac{1}{2}$  make an ounce Avoirdupois. After this manner I made the observations of which I am going to give an account, with all the nicety and care I was capable of.

I begin with the herring, which makes a distinguished figure in these two counties of Norfolk and Suffolk, and a considerable part of our commerce, when salted and smoked. One of the above-mentioned authors supposed, they may have 9 or 10,000 eggs: of several I examined, I found none which had so few as 20,000; and in one I found 36,960. The intermediate numbers which appeared to me on

numbers of others that I could not tell at all. Those that I told were of all sizes; and though there were but 56 very large eggs, yet the creature was extremely distended. Now it does not appear possible that all the 936 eggs should grow to the bulk of the largest of their companions without destroying the fish, since the growing of 56 to such a size as to weigh about  $1\frac{1}{2}$  grain distended it in such a manner as I have hardly seen in any other species of fish. In some very large sticklebacks, which weighed 45 or 50 grains, I have found between 2 and 300 of these large eggs, along with great numbers of smaller ones, so that the number of large eggs seems to bear some proportion to the size of the fish, by which means a greater number of eggs, answerable to their size, may be deposited in the same time in which the smaller fish of this species discharge their less numerous spawn. I will only farther observe here, that if this be the case as to the other fish, the number of their eggs may, on this account, appear very different to different observers.

examination,

examination, may be met with in a table that I shall place at the end of this paper, which will give the particulars relating to this sort of fish, and several others, in the shortest manner, but with sufficient distinctness.

The next that came under my inspection was the smelt. These, it is well known, are a very small sort of fish, and are frequently used for garnish to those that are larger. In one of these, which did not weigh quite two ounces, I found 38,272 eggs; and in none so few as 20,000; excepting one, which was extremely small, not weighing above  $289\frac{1}{2}$  grains, in which very small fish I found 14,411. This was amazing.

I was much more surprized, when, after this, I learnt what was the fecundity of mackarel. This no author that I met with gave an account of, though it is a fish so extremely common. In one large fish of this kind, weighing somewhat better than 1 $\frac{1}{4}$ lb, I found 454,961 eggs; in a second, of much the same weight, 430,846; and in a third, which weighed but about 1lb 2oz. I found 546,681.

I was astonished upon this, that Bradley should call the supposed fecundity of carp, which he makes to be but about 20,000, so surprizing; or that even Petit's observation, which made it appear, that in some fish of that species the eggs amount to 342,144, should cause the carp to be selected as the most extraordinary fish for increase, after the cod, when it appears to be so much greater in mackarel (which is at the same time so common a fish), as to be not much short of the proportion of 5 to 3, in the last I examined.

I shall

I shall leave it to the table at the close, to give an account of the prolific quality of some other fish, whose eggs I have counted, and shall pass on to what I have found in the carp, which species Petit examined. As to this fish, though I cannot say I have found the eggs, in those that have come under my notice, so numerous as he did; yet, as I have found the number much larger than Bradley mentions, so I make no doubt but that Petit really found them amount to 342,144; and I would add, that I dare say they may be found to be much more numerous still in large fish of this kind, since in one that I examined, weighing but  $16\frac{3}{4}$  oz. I found 101,200; and in another, which weighed no more than  $25\frac{1}{2}$  oz. I found 203,109, and carp grow to a much larger size than the biggest of these, but I could not procure any of those large carp that were full of spawn.

If I failed in verifying Petit's number of eggs in a carp, I found those of a tench to exceed it, more than once, which Bradley reckons not to produce more than half the number a carp does, or 10,000. For I found in one tench, which weighed  $2\frac{1}{4}$  lb, 383,252 eggs at least; and in another that weighed not quite  $1\frac{1}{4}$  lb, 350,482.

As to perch, which one of those authors I mentioned puts upon a par with carp, I could get none of any size. The largest, which weighed but 8 oz. 9 dr. contained 28,323 eggs; and a second of 5 oz. 10 dr. had in it 20,582. They seem, however, to be much less prolific, in proportion to their bulk, than tench, since the largest of these had but about 28,323 eggs, and I found a tench of nearly that size, weighing but 8 oz.  $14\frac{3}{4}$  dr. produced 83,104.

Bradley



Bradley seems to have been as careful not to be guilty of exaggeration with respect to the cod-fish, as in the other cases. He estimates them at a million, while Lewenhoeck affirmed that he found above nine millions of eggs, in one of middling size. The spawn of one of that size which I examined, that is to say, one of 18 or 20lb weight, I found to contain between three and four millions, if my friend's weights were accurate, for I made the examination at a distance from home; and by a subsequent observation at home, I have reason to think there was this number in it, though I was prevented pursuing my second examination so far as I would have done, by some particular occurrences. According to this, there is nothing incredible in Lewenhoeck's account; his fish, I suppose, being remarkably distended with spawn, and for that reason perhaps thought, by that inquisitive and curious person, a subject that ought not to pass unexamined.

I have hitherto mentioned no flat fish, nor do I remember that any author has given us an account of their fecundity. I imagined, from their make, it could not be extraordinary; I was therefore extremely surprized to find in the first flounder I examined and which did not weigh quite three ounces, 133,407 eggs; in a second, which weighed little more than  $3\frac{1}{4}$  ounces, 225,568; and much more still when I discovered in a large one, that weighed about  $24\frac{1}{4}$  oz. and which was of that sort that is spotted like a plaice, as Ray has told us some flounders are, 1,357,400: this was truly astonishing.

The number of eggs that a foal produces, I have observed to be great, but nothing like that which I

found in flounders, finding in one, which did not fall much short of a pound, rather more than 100,000; and in another, that weighed about five ounces, 38,772.

To make this disquisition still more extensive, I examined two or three kinds of shell-fish. I found in a lobster of  $14\frac{1}{2}$  oz. when in the shell, and of  $10\frac{3}{4}$ , when divested of it, 7,227; and in another that weighed  $2\frac{1}{4}$  lb, and out of the shell somewhat better than  $1\frac{3}{4}$  lb, I told 21,699 eggs.

I took also the pains to tell all the eggs of some shrimps, one by one, and found in one which weighed  $17\frac{1}{2}$  grains only, 3057; in another of 31 gr. 4090; and in a third of 39 gr. 6807.

This, considering the smallness of the creature, is more remarkable than the fruitfulness of the lobster; but neither is the one or the other to be compared, in this respect, to the crab, for in a large one, weighing near  $1\frac{1}{4}$  lb, but not quite, I found that the spawn weighed 687 gr. but the eggs were so minute, and at the same time adhered so close together, that I could not number them distinctly; however, the weight of the whole, and the minuteness of the eggs, show that they must have been very numerous; and I believe from a rough estimate I made, that they exceeded a million.

The table, at the close, gives all these accounts, with the addition of several more particulars, in a very short compass. The first column contains the names of the fish which I examined; the second their weight; the third the weight of their spawn; the fourth their fecundity; and, as I supposed some persons might be desirous to know how large a  
portion

portion of spawn I weighed in each case, I have set down the number of grains in each such portion, in a fifth; the number of eggs found in a grain, by this method is seen in a sixth, by which we may give some guess at the different sizes the eggs of each species are of, when they are excluded; and I have made the time of examining each fish respectively a seventh; which possibly may be of some use to those who may have an inclination to repeat any of these observations, as from thence may be learnt something concerning the most advantageous time of examining these creatures, which certainly ought to be as nearly as we can, when the eggs are come to their full size, and before any of them are deposited. However, after all, if my notion is just, that some species deposit a part of their eggs come to their full growth, before others laid the same year are big enough to be told with distinctness, the accounts of the fecundity of such fish must be extremely defective; and this I apprehend, amongst those I have examined, is the case of mackarel, carp, tench, and some others; in herring, &c. there does not appear such a difference in the size of different eggs.

From this table it appears, that the size of the eggs is nearly the same in great and small fishes of the same species, at the same time of the year; that the quantity of spawn is, usually, nearly proportionate to the size of the animal, from whence we may give a tolerable guess at the greatest fecundity of each species, if we know to what weight they have been found to grow while in a breeding state; we may likewise settle their produce at a medium, upon learning what is the mean size of each species

when in the forementioned state, but we see, however, that this is not universal, nor consequently perfectly exact, some fish being much more prolific than others of the same size, and species.

To conclude, the great fecundity of fish is not the only thing that affects the imagination, when we are examining matters of this sort: the extreme disproportion between their size when they first appear in the water after hatching, and that of their full-grown state, as well as the little proportion that is to be observed between the bulk of fish of different species and that of their eggs, are things that are very amazing to persons of a curious turn. The egg of a smelt, which at its full growth weighs but two or three ounces, appeared, in those I examined, to be larger than those of a cod-fish, which weighed eighteen or twenty pounds, and might have grown to double that bulk; and that of a stickleback, which is the smallest of all known fish, was found to be above six times bigger than the largest I ever observed in a smelt. What becomes of such amazing numbers of young fish, and why some are made so extremely prolific, the flounder and crab in particular among the smaller sorts, would doubtless be highly entertaining subjects, if duly illustrated; but these are enquiries I have no opportunity of making.

The TABLE.

| 1.<br>Names of the fish. |                    | 2.<br>Their weight. | 3.<br>Weight of<br>the spawn. | 4.<br>Fecundity | 5.<br>The portion<br>of sp. weighed | 6.<br>N <sup>o</sup> . of eggs<br>to a grain | 7.<br>Time of exam. |
|--------------------------|--------------------|---------------------|-------------------------------|-----------------|-------------------------------------|--|---------------------|
|                          |                    | oz. dr.             | grains.                       |                 | grains.                             |  |                     |
| Carp                     | N <sup>o</sup> . 1 | 16 12               | 1265                          | 101.200         | 46                                  | 80   | May 25              |
|                          | N <sup>o</sup> . 2 | 25 8                | 2571                          | 203.109         | 55                                  | 79   | April 4             |
| Cod-fish                 |                    | —                   | 12.540                        | 3.686.760       | 29                                  | 294  | Dec. 23             |
| Flounder                 | N <sup>o</sup> . 1 | 2 14                | 182½                          | 133.407         | 23                                  | 731  | Feb. 21             |
|                          | N <sup>o</sup> . 2 | 3 8½                | 152                           | 225.568         | 19                                  | 1484   | Dec. 18             |
|                          | N <sup>o</sup> . 3 | 6 12                | 598                           | 351.026         | 26½                                 | 587  | March 14            |
|                          | N <sup>o</sup> . 4 | 24 4                | 2.200                         | 1.357.400       | 24½                                 | 617  | d <sup>o</sup> .    |
| Herring                  | N <sup>o</sup> . 1 | 4 3                 | 367                           | 32.663          | 48                                  | 89   | Oct. 8, 1763        |
|                          | N <sup>o</sup> . 2 | 5                   | 236½                          | 21.285          | 48½                                 | 90   | 29                  |
|                          | N <sup>o</sup> . 3 | 3 13                | 259                           | 23.560          | 52½                                 | 91   | Oct. 2, 1764        |
|                          | N <sup>o</sup> . 4 | 5 10                | 480                           | 36.960          | 53                                  | 77   | 25                  |
|                          | N <sup>o</sup> . 5 | 4 6½                | 366                           | 29.646          | 57                                  | 81   | d <sup>o</sup> .    |
|                          | N <sup>o</sup> . 6 | 4 8                 | 420½                          | 27.753          | 51                                  | 66   | Nov. 3              |
|                          | N <sup>o</sup> . 7 | 5 1                 | 490½                          | 32.863          | 41½                                 | 67   | Oct. 18             |
| Lobster                  | N <sup>o</sup> . 1 | 14 8                | —                             | 7227            | —                                   | 14   | April 4             |
|                          | N <sup>o</sup> . 2 | 36 0                | 1671                          | 21.699          | 129                                 | —  | Aug. 11             |
| Mackarel                 | N <sup>o</sup> . 1 | 20 —                | 1027                          | 454.961         | 33                                  | 443  | June 20, 1764       |
|                          | N <sup>o</sup> . 2 | 20 —                | 949                           | 430.846         | 24½                                 | 454  | 29                  |
|                          | N <sup>o</sup> . 3 | 18 —                | 1223½                         | 546.681         | 32½                                 | 447  | 18, 1765            |
| Perch                    | N <sup>o</sup> . 1 | 8 9                 | 765½                          | 28.323          | 85                                  | 37   | April 5             |
|                          | N <sup>o</sup> . 2 | 5 10                | 502                           | 20.582          | 85                                  | 41   | 6                   |
| Pickerel                 | N <sup>o</sup> . 1 | 56 4                | 5100½                         | 49 304          | 70                                  | 9½   | April 25            |
|                          | N <sup>o</sup> . 2 | —                   | 3248                          | 80.388          | 76½                                 | 24½  | Nov. 25             |
|                          | N <sup>o</sup> . 3 | 48 10½              | 3184                          | 33.432          | 43                                  | 10½  | March 19            |
| Prawn                    | N <sup>o</sup> . 1 | (127 gr.)           | —                             | 3.806           | —                                   | 243  | May 12              |
|                          | N <sup>o</sup> . 2 | (94½ gr.)           | —                             | 3.479           | —                                   | 287  | d <sup>o</sup> .    |
|                          | N <sup>o</sup> . 3 | (100½ gr.)          | —                             | 3.579           | —                                   | 247  | d <sup>o</sup> .    |

Roach

| 1.<br>Names of the fish.                           | 2.<br>Their weight   | 3.<br>Weight of<br>the spawn                           | 4.<br>Fecundity                                 | 5.<br>The portion<br>of sp. weighed                                       | 6.<br>N <sup>o</sup> . of eggs<br>to a grain | 7.<br>Time of exam.                         |  |
|--|--|--|---|---|--|---|--|
|  | oz. dr.  | grains.  |   | grains.   |  |   |  |
| Roach (or what<br>I took to be of<br>that species) | N <sup>o</sup> . 1<br>N <sup>o</sup> . 2<br>N <sup>o</sup> . 3<br>N <sup>o</sup> . 4<br>N <sup>o</sup> . 5<br>N <sup>o</sup> . 6<br>N <sup>o</sup> . 7 | 2 —<br>6 8<br>3 8<br>2 2<br>10 6½<br>9 10¾<br>3 8      | 114<br>671<br>346½<br>153<br>361<br>417<br>213½ | 9.604<br>43.615<br>29.799<br>9.486<br>81.586<br>113.841<br>45.475         | —<br>68<br>42½<br>42½<br>39<br>42<br>20      | —<br>65<br>86<br>62<br>226<br>273<br>213    | April 4<br>May 4 1764<br>d <sup>o</sup> .<br>5<br>2 1765<br>6<br>24                                  |
| Shrimp (with<br>light coloured<br>spawn.)          | N <sup>o</sup> . 1<br>N <sup>o</sup> . 2<br>N <sup>o</sup> . 3   | (17½ gr.)<br>(39 gr.)<br>—                             | 3<br>7<br>—                                     | 3.057<br>6.807<br>4.601   | —<br>—<br>—                                  | 1000<br>972<br>—                            | May 3<br>d <sup>o</sup> .<br>d <sup>o</sup> .  |
| Ditto (with<br>dark colour)                        | N <sup>o</sup> . 1<br>N <sup>o</sup> . 2   | (31 gr.)<br>(22 gr.)                                   | 5<br>4  | 4.090<br>2.849  | —<br>—                                       | 818<br>712                                  | d <sup>o</sup> .<br>d <sup>o</sup> .   |
| Smelt  | N <sup>o</sup> . 1<br>N <sup>o</sup> . 2<br>N <sup>o</sup> . 3<br>N <sup>o</sup> . 4<br>N <sup>o</sup> . 5<br>N <sup>o</sup> . 6                       | 2 —<br>(289½ gr.)<br>1 14<br>1 12<br>1 7<br>1 5        | 149½<br>50<br>157½<br>145½<br>149<br>136        | 38.278<br>14.411<br>29.925<br>30.991<br>24.287<br>23.800                  | 30<br>—<br>40½<br>20<br>20<br>20             | 256<br>288<br>190<br>213<br>163<br>175      | Feb. 21<br>Mar. 21, 1764<br>27, 1765<br>28<br>d <sup>o</sup> .<br>d <sup>o</sup> .                   |
| Soal   | N <sup>o</sup> . 1<br>N <sup>o</sup> . 2   | 14 8<br>5 —  | 547½<br>179½                                    | 100.362<br>38.772   | 20<br>20                                     | 185<br>216                                  | June 13<br>28  |
| Tench  | N <sup>o</sup> . 1<br>N <sup>o</sup> . 2<br>N <sup>o</sup> . 3<br>N <sup>o</sup> . 4<br>N <sup>o</sup> . 5<br>N <sup>o</sup> . 6<br>N <sup>o</sup> . 7 | 40 —<br>28 8<br>8 14¾<br>9 8<br>12 8<br>27 9½<br>14 15 | —<br>533½<br>224<br>284½<br>366<br>1969<br>866  | 383.252*<br>280.087<br>83.104<br>108.963<br>138.348<br>350.482<br>138.560 | —<br>25<br>20<br>20<br>22½<br>23<br>20       | —<br>525<br>371<br>383<br>378<br>178<br>160 | May 28, 1764<br>3, 1765<br>10<br>d <sup>o</sup> .<br>d <sup>o</sup> .<br>June 11<br>d <sup>o</sup> . |

\* N<sup>o</sup>. 1. of the tench certainly had a much larger number of eggs; but being extremely distended with spawn, and unluckily let fall before it was brought to me, the enveloping skin in which the eggs were contained was broke, which made it difficult to determine some circumstances relating to this fish; it however had the number of eggs I have set down, at the lowest way of reckoning, and I believe many thousands more.

I have taken no notice of several fractions in the number of eggs contained in a grain in many cases, choosing to fall rather below than to exceed the truth, in all the fish I have given an account of in this table, I have been scrupulously exact in all particulars, excepting what are contained in the second column, which gives the weight of the fish I examined, in which the utmost nicety was not necessary: some few might weigh a little more or a little less; but all were nearly of the weight set down, and much the greatest part exactly so.